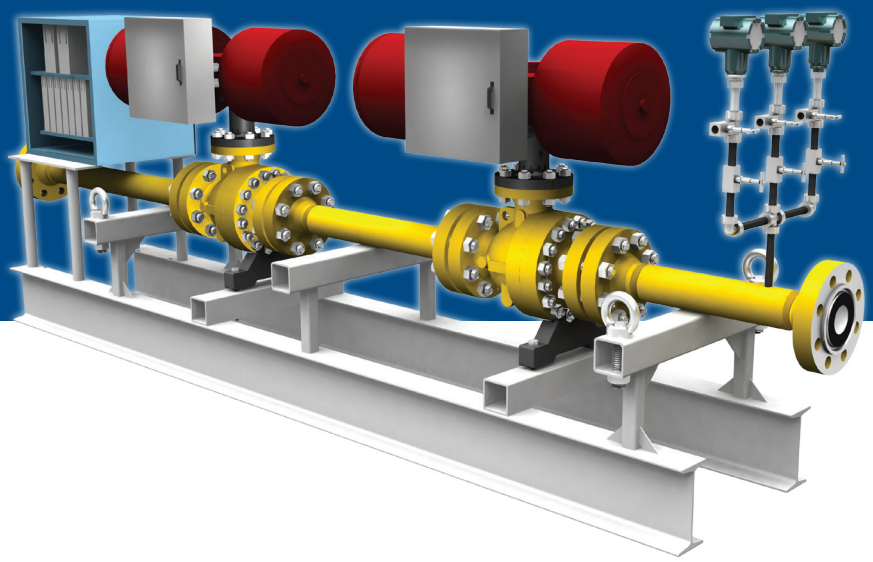
HIPPS
High Integrity Pressure Protection System



L&T Valves

L&T Valves

L&T Valves Limited (Formerly Audco India Limited) is a wholly owned subsidiary of Larsen & Toubro. Backed by a fifty-year track-record of excellence and world-leading innovation, the company provides engineered flow-control solutions for key sectors of the economy such as oil & gas, power, petrochemicals, chemicals, fertilizers and pharmaceuticals.

Product Range:

- Gate, Globe & Check Valves
- Valves for Power
- Pipeline & Process Ball Valves
- Triple-offset Butterfly Valves
- Flanged & Wafer-type Butterfly Valves
- Double Block and Bleed Plug Valves
- Control Valves
- Customised Solutions

Designs for the valves are created by an experienced team of valve experts who have a deep understanding of user-industry processes. An extensive manufacturing and quality assurance infrastructure ensure that world-class designs are transformed into high performance products. Every phase of manufacture is governed by an institutionalised environment, health and safety policy.

L&T Valves marketing network spans the globe reinforced by strategic alliance with key international distributors. In India, it has a presence in every industrial centre through a network of offices, field engineers, distributors, automation centres and service franchisees.

High Integrity Pressure Protection System

L&T Valves offers a range of customised SIL-3 capable High Integrity Pressure Protection Systems (HIPPS) for over-pressure protection leveraging our expertise of five decades in flow-control and system integration.

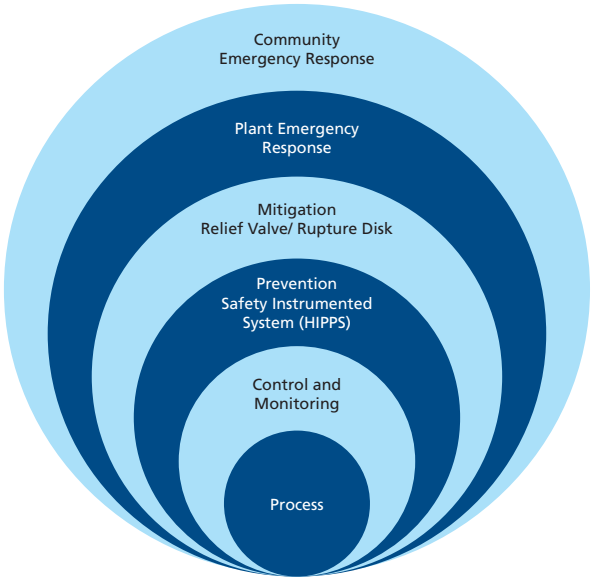
High Integrity Pressure Protection System (HIPPS) is a Safety Instrumented System (SIS), which by definition, is a distinct, reliable system used to safeguard a process to prevent a catastrophic release of toxic, flammable, or explosive chemicals.

In industrial plants, flare systems are primarily used for burning off flammable gases released by pressure relief valves during unplanned over-pressurization of plant equipment. Flaring and venting constitute a significant source of greenhouse gas (GHG) emissions, and the elimination of GHG emissions from flaring in the world would account for at least 10% of total emissions reductions as per the Kyoto protocol.

HIPPS can be employed to prevent over-pressurization of a plant by shutting-off the source of the high pressure gas rather than by releasing it to the atmosphere. This system closes the source of over-pressure within two seconds and has at least the same reliability as a safety relief valve or flare system.

As per ASME Section VIII, UG-140, which covers 'Over-pressure Protection by System Design', HIPPS can be used for the following applications:

- Chemical reactions so fast the pressure propagation rate could result in loss of containment prior to the relief device opening
- Chemical reactions so fast the lowest possible relieving rate yields impractically large vent areas
- Exothermic reactions occurring at uncontrollable rates
- Plugging, polymerization, or deposition formed during normal operation
- Reactive process chemicals relieved into lateral headers with polymerization and thus plugging, rendering the relief device useless;
- Multi-phase venting, where actual vent rate is difficult to predict
- Reducing GHG through regulations such as Kyoto protocol



Codes & Standards

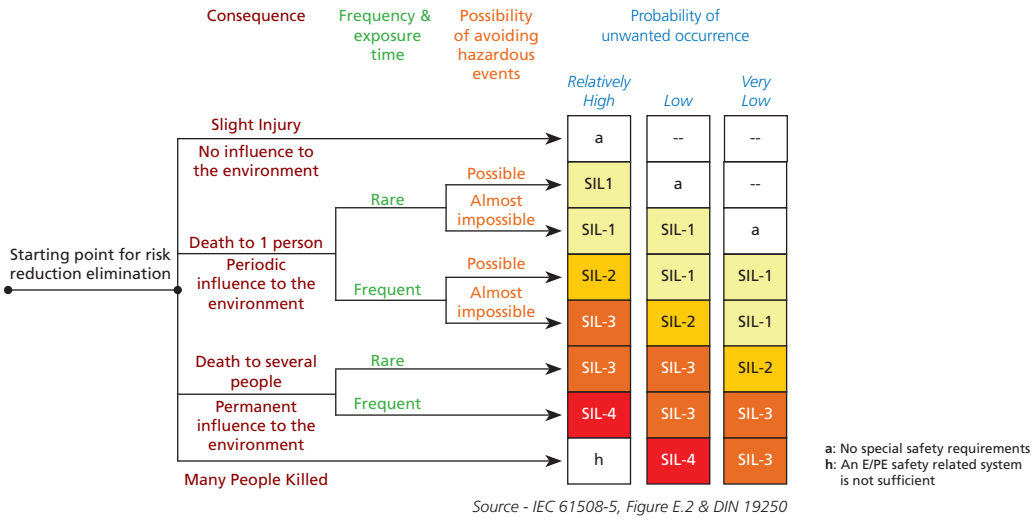
API 521 and ASME code case 2211 spell out the conditions when a SIS can be used as an alternative to a pressure relief device. HIPPS must provide an installation that is as safe as or safer than the pressure relief device that it replaces.

In addition, the SIS design must comply with international standards IEC 61511 and IEC 61508. IEC 61508 is a standard for functional safety of electrical, electronic and programmable electronic equipment and included mechanical components that are necessary to execute the safety function. IEC 61511 was developed for integrators, SIS designers and users as it deals with process sector implementation of the IEC 61508 standard. IEC 61511 has been adopted in the US as ANSI/ ISA S84.00.01.

Implementing HIPPS as an SIS would result in risk reduction of the plant facility by prevention method rather than mitigation. The recommended safety integrity levels for HIPPS would be either SIL-3 or SIL-4. The Risk reduction factor RRF and Average probability of failure on demand ($PFD_{avg.}$) listed in IEC 61508 are:

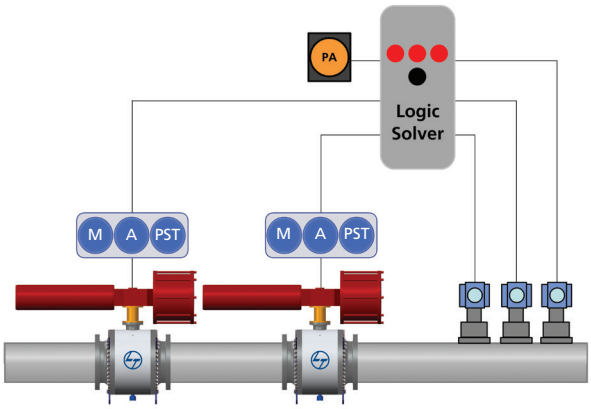
Safety Integrity Level	Risk Reduction Factor (RRF)	PFD (Avg. Probability of Dangerous Failure on Low Demand Mode)	PFH (Avg. Frequency of Dangerous Failure on High Demand Mode)
SIL-4	100,000 to 10,000	$\geq 10^{-5}$ to $<10^{-4}$	$\geq 10^{-9}$ to $<10^{-8}$
SIL-3	10,000 to 1000	$\geq 10^{-4}$ to $<10^{-3}$	$\geq 10^{-8}$ to $<10^{-7}$
SIL-2	1000 to 100	$\geq 10^{-3}$ to $<10^{-2}$	$\geq 10^{-7}$ to $<10^{-6}$
SIL-1	100 to 10	$\geq 10^{-2}$ to $<10^{-1}$	$\geq 10^{-6}$ to $<10^{-5}$

IEC 61508 lists possible methods to determine applicable Safety Integrity Levels, such as Risk Graph Method given below.



Source - IEC 61508-5, Figure E.2 & DIN 19250

Components of a HIPPS system



A typical HIPPS system comprises the following:

- Three pressure sensors (2oo3 voting) that detect the over pressure in the line
- A logic solver which receives and processes the input signal from the sensors and transmits the output to the Solenoid Valve in the final element.
- A final element (Actuated Valve) which perform the emergency closure action via a Solenoid Operated Valve (SOV) to bring the process to a safe state. Typically, 3 SOVs are used - a manual-reset SOV (M), an auto-reset SOV (A) and one for Partial Stroke Testing (PST).

The above schematic is a typical HIPPS architecture and the components in the loop can vary according to customer specification and requirement. L&T Valves can offer you a 'Ready to Fit' skid designed for customer requirements.

Pressure Transmitters

The pressure transmitters detect the high pressure in the system and the safety loop may include a minimum of three transmitters, which operate in a 2oo3 voting logic, to achieve the SIL-3 requirement. Thus failure of one transmitter channel to respond will not affect safety integrity. If a fault develops on one transmitter channel this would be revealed by an alarm and can be intervened without causing HIPPS activation.

- Transmitters used in a voting arrangement are diverse, that is, of different manufacturers or technologies, to reduce the likelihood of common mode failures.
- Common pressure transmitters used employ capacitance, piezo-resistive or Silicon resonant technology.
- Based on the requirement, the three pressure transmitters can either be directly connected to the main line with double block and bleed valve arrangement or alternatively a High Integrity Manifold Block (HIMB) shall be used to connect Gauge Pressure Transmitters with process.
- When provided, HIMB shall have integrated block and bleed facility for three transmitters & shall be mechanically interlocked with tamper-proof facility in such a way that only one pressure transmitter can be isolated or vented at any one time.

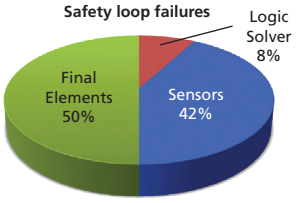
Logic Solver

Control systems from L&T Electrical and Automation

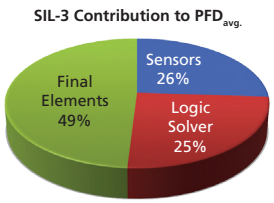
The Logic Solver processes signals from the sensors and closes the final element by de-energising the SOV. The logic solver hardware must be designed to meet the SIL-3 performance requirements, as a minimum, in accordance with IEC 61508. The logic solver can be either solid state, or programmable electronic systems (PE). Programmable electronic systems are provided with additional self-diagnostics and fault tolerance.

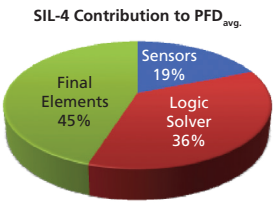
Final Element

Final elements (Actuated Valves) are accorded the highest priority in a HIPPS loop as studies suggest that they account for 50% of safety loop failures historically and calculations suggest that their contribution to $PFD_{avg.}$ is the highest when compared with the sensors and logic solver. Thus selection and design of valves and actuator is of paramount importance in a safety loop.



Source: Oreda (Analysis of Safety Loop Failures)





Source: Exida

Shutdown Valves

Selection of valves for HIPPS systems depends on reliability of the valve failure stroke, seat tightness, and impact of process conditions on valve drive train and seat design. A 1oo2 voting logic is normally specified for the HIPPS shutdown valves (in accordance with IEC 61511).

Trunnion-mounted Ball Valves (TMBV) are preferred for HIPPS applications as they provide the best flow performance for shut down applications.

Soft and metal seats can be offered.

Triple-offset Butterfly Valves (TOBV), can be used in clean tight shutoff applications such as LNG where pressure drop is not a concern.

The disc seat could either be a laminar seat or a solid seat based on the application.

Product Range and Options

Valve Types	Trunnion Mounted Ball Valve	Triple Offset Butterfly Valve
Sizes	2" to 56"	3" to 64"
Pressure Rating	Class 150 to 2500	Class 150 to 600
Temperature Range	-196°C to 400°C	-196°C to 538°C
Seat Options	Soft Seat, Metal Seat	Metal-Graphite Laminated Seat, Solid Metal Seat
Body Materials	Carbon Steel, Stainless Steel, Duplex & Super Duplex Steels, Special Alloys, Carbon Steel with Stainless Steel/ Inconel Overlay	
Actuation Options	Pneumatic and hydraulic. Fail safe position provided by spring return.	

Features of Final Element:

- **Certified to SIL-3**
  L&T Actuated TMBV and TOBV are certified to SIL-3 by an independent third party


Certificate / Certificat
Zertifikat / 合格証
L&T 1004017 C001
exida hereby confirms that the:
Ball Valves
L&T VALVES LIMITED
Tamil Nadu - India
Has been assessed per the relevant requirements of:
IEC 61508 : 2010 Parts 1-7
and meets requirements providing a level of integrity to:
Systematic Integrity: SIL 3 Capable
Random Integrity: Type A Element
PFD_{avg} and Architecture Constraints must be verified for each application
Safety Function:
The Ball Valve will move to the designed safe position per the actuator design within the specified safety time.
Application Restrictions:
The unit must be properly designed into a Safety Instrumented Function per the Safety Manual requirements.
Evaluating Assessor
Certifying Assessor
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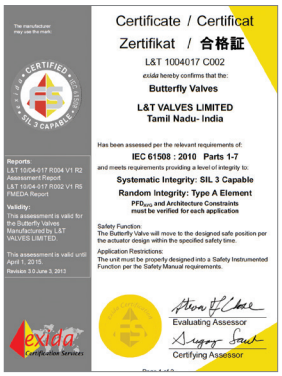
Certificate / Certificat
Zertifikat / 合格証
L&T 1004017 C002
exida hereby confirms that the:
Butterfly Valves
L&T VALVES LIMITED
Tamil Nadu- India
Has been assessed per the relevant requirements of:
IEC 61508 : 2010 Parts 1-7
and meets requirements providing a level of integrity to:
Systematic Integrity: SIL 3 Capable
Random Integrity: Type A Element
PFD_{avg} and Architecture Constraints must be verified for each application
Safety Function:
The Butterfly Valve will move to the designed safe position per the actuator design within the specified safety time.
Application Restrictions:
The unit must be properly designed into a Safety Instrumented Function per the Safety Manual requirements.
Evaluating Assessor
Certifying Assessor

- **Partial Stroke Testing (PST)**
  Partial stroke testing capability is built into each HIPPS shutdown valve, for testing (closure limited to 30%) and real time diagnostics. The PST data could be recorded with remote status indication in SCADA or an equivalent protocol.
- **Fast Acting**
  HIPPS valves designed to go from full open to full close in ≤ 2 seconds
- **Tight Shut-off**
  Leakage requirements as per Class V or VI of ANSI/ FCI 70-2
- **Fugitive Emission**
  Meets ISO 15848-1 requirements
- **Fire Safe**
  Valves fire safe tested to API 607 or API 6FA

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